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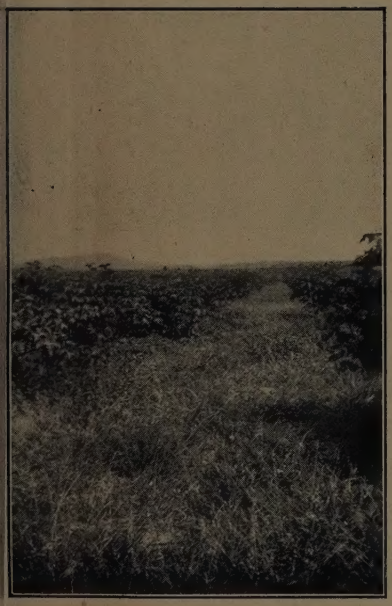
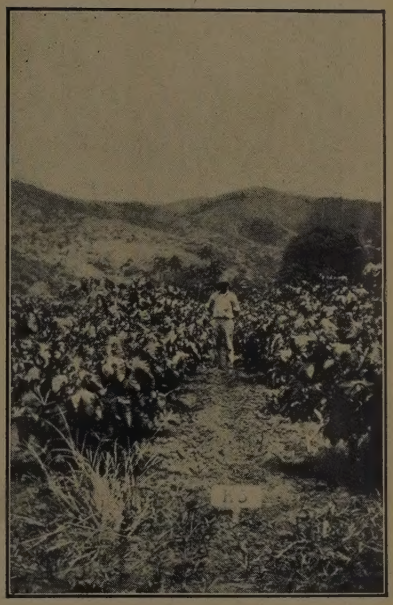


Sea Island and Kidney types have done best at the Station.



K 3 type of Single Seeded Kidney Cotton from New Guinea.

A general view of the Cotton Experimental Station
in the Sigatoka Valley.

Experiments in ratooning Kidney Cottons are
being conducted in this field.

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THE POSSIBILITIES OF A NEW VARIETY OF COTTON FOR FIJI.

By Ross R. ANSON, Cotton Specialist.

DURING the past few years the uncertainty of the market for Sea Island cotton has made it necessary to carry out experiments, with a view to seeing whether it will be possible to substitute the growing of it by some other variety which will be more saleable, and at the same time give the grower as good a return per acre.

VARIETAL EXPERIMENTS.

Several varieties have been tried out at the Cotton Experiment Station including Kidney, Meade, Acala, Tanguis, Pima, Sakellaridis, and a few useful types of cotton have been crossed with Sea Island. The variety which has shown the greatest promise up to the present is a Kidney Hybrid. It originated from a few seeds from five of the most promising of twenty-eight single plant selections, made by Mr. G. Evans from Kidney Hybrid cottons found growing at Kayapet, Markham Valley, New Guinea; of the original twenty-eight selections eleven possessed conglomerate seeds, but the remaining seventeen had seeds which did not adhere together as in ordinary Kidney cotton. Five of these which appeared to be the best, were sent out to Fiji by the Empire Cotton Growing Corporation for trial.

SELECTION WORK.

Last season we were unable to do much selection work, as it was necessary to study the behaviour of each hybrid plant. All the free seeded ones were grouped together, and careful observations were made. Points such as pest resistance, vigour, productivity, size of bolls, length and uniformity of staple, flower colourings, &c., were noted. Four desirable types were selfed and planted on an isolated plot this season.

The type of plant which we are attempting to produce is a robust one with an open habit of growth and large full opening bolls, possessing strong lint of uniform staple length, and good drag. The plant should grow from a single stem or trunk. It should have as few vegetative branches as possible and none within twelve inches of the ground, so that it may be treated with tree tanglefoot, and thus rendered as immune as possible from the second generation of cotton stainers.

COMPARISON WITH SEA ISLAND.

It is a well known fact that owing to its length, strength, and fineness of staple, Sea Island has always commanded a higher price than other cottons, but the size and character of the bolls make picking difficult, and a picker

can rarely maintain an average of more than 30 lb of seed cotton per day. A cotton that will compare favourably with Sea Island from a grower's point of view, must therefore be a type which possesses a larger boll, a higher percentage of lint, a higher percentage of first-grade cotton to the acre, which is a better yielder and which at the same time produces lint of such quality that the price will be as close as possible to that of Sea Island.

During the past four seasons the average percentage of Sea Island A and B grades has been high (69·41 per cent.), and it will not be an easy matter to find a cotton that will beat this. The grade and class is governed to a great extent by the weather conditions at the time of maturity, and the drier the weather at the picking time the higher the percentage of good quality cotton. According to the rainfall statistics taken over a period of twenty years in the dry zones of Vitilevu and Vanualevu Islands, the driest weather was experienced during the months of June, July, August, and September. The Sea Island crop when planted in mid November usually reaches maturity in April and picking is continued until the end of July. The Kidney Hybrid planted at the same time does not reach maturity until June and picking continues until the end of September. This just fits in with the driest months and it is hoped that it will therefore be possible to obtain a higher percentage of first grade cotton than is the case with Sea Island. During the present season this seems to be precisely the case and the Kidney Hybrid has so far shown most of the other characteristics which are necessary to make it compare favourably with Sea Island, that is from a grower's point of view, but as yet the variety has not been properly fixed to type and a few individual plants show signs of reverting to one or other of the parent plants and it will be necessary to continue with plant selection work until the type has become commercially pure.

Fixing of Type.

During the first season of issue to a community of growers, it will only be possible to make a general mass selection; it would also be advisable to combine with this method the practice of examining the seed, rejecting all small light gin cracked seed, together with any that shows signs of irregularity of type. For the ultimate fixing to a commercially pure type, the method adopted by most cotton breeders is that of the "Progeny Row System," which is one based on the separate raising of progeny of "selfed" individually selected plants.

To begin with several plants are selected as the best to be found, and the seed from each of these is saved separately. The reason for having more than one plant to start with is that the degree to which the characters of the parent are transmitted are found to vary with different plants. The following year each of these lots of seed is used to establish a row (say of 100 plants). The rows should be adjacent to each other and should either occupy an isolated position or be placed amongst the same variety of cotton of good type, these precautions being taken to prevent as far as possible, the crossing with pollen from inferior plants. Any plants of noticeable inferiority are pulled up as soon as detected. When the plants come into bearing the rows are compared with each other, and the rows which possess the required characters with the greatest regularity are selected. In these again a number of best plants are marked and the seed from each individual saved separately for next year's rows. The seed from the remainder of the plants in each selected row is saved and used for planting separate plots, while that from the non-selected rows should also be kept for planting, since it may be expected to be above the average.

The following year there will be—

1. a new set of rows from the last selected plants;
2. as many seed plots as there were selected rows in the previous year;
3. a certain amount of cotton planted from seed from non-selected rows.

For reasons connected with crossing already indicated the seed plots should be planted around the rows. The selection of rows and individual plants and the planting of seed plots, are repeated in this, and each succeeding year. From the seed plots sufficient seed will be obtained each year to plant a large area. If it is not sufficient for an isolated community of growers, the process may be carried on another step, using the areas upon which the seed cotton is grown, as a seed plot for the following year.

Conclusion.

The plant which shows promise of being the best suited to conditions in Fiji, is K 11, but it is not expected to supply a sufficient quantity of pure seed for distribution to an isolated community during the coming season, and in order to test the variety under commercial conditions it will most probably be necessary to distribute seed from K 8, which lacks the lint qualities of K 11, but makes up for this in other respects. It will be possible to distribute seed from K 11 to a separate community in one year's time, and if it proves to be a better cotton, to replace K 8 by it in the following year. In case the demand for Sea Island cotton should increase at some future date, and it should prove to be more remunerative to the growers than the Kidney Hybrid types, it would be wise to keep a stock of pure seed continually on hand, and in order to do this it would be necessary to confine a small island such as Vatulele to the growing of it exclusively.

REPORT ON THE WORK OF THE COTTON EXPERIMENT STATION, SIGATOKA, FOR THE SEASON 1927–28.

By Ross R. Anson, Cotton Specialist.

During the past season the experimental work has been conducted on similar lines to those described in my report on the operations of the previous season. In order to provide adequate isolation for the increase plots of the single plant selections, and to allow for crop rotation, it was found necessary to increase the area of the Station and an additional 134 acres has therefore been acquired. This area comprises 50 acres of flat land which, although at present heavily covered with guava and other pests, consists of light friable river silt of great depth, and fair drainage. It is a first-class cotton soil. The remaining 84 acres consists of hill slopes, most of which are not suitable for cultivation purposes, and will be used for paddocking the farm stock. The total area of the Station has now been brought up to 166 acres, of which 80 are suitable for cultivation. This should greatly facilitate the economic working of the Station.

Season.—Continuous rains at the commencement of the season hindered planting operations and many growers had their crops completely washed out, while others were unable to secure a good stand owing partly to faulty seed beds, and partly to the continuous rains and relatively high humidity

in the atmosphere which caused a large percentage of the seed to rot, and poor germination resulted.

At the Station we were more fortunate, thanks to drains and a tractor plough, which enabled us to prepare and plant up fairly large areas in a short space of time, and to take full advantage of favourable weather conditions. In this way we managed to obtain an excellent stand throughout before the heavy rains which set in in February and lasted until May, causing all varieties to put on an abundance of wood and to grow lank and sappy. Some of the Kidney Hybrids and Tanguis cottons grew ten feet high. It was decided to have these topped in order to check the growth, allow the sun to penetrate and to facilitate picking. A sharp cane knife was used for this purpose and plants were pruned to a height of five feet. They were cut by an upward motion of the knife, care being taken to strike the branches just above a node in order to avoid mutilating them as much as possible. Although this somewhat drastic treatment checked the growth and caused plants to be considerably later in reaching maturity, it had the desired affect, and turned a crop which would otherwise have been an eminent failure into a moderately good yielder.

The rains ceased suddenly at the end of May, and thus the later varieties reached maturity in favourable weather, which lasted for four months and added considerably to the ease of picking. A few light showers were experienced, but they were not sufficient to cause any injury to the seed cotton.

Kidney Hybrids.—All the cotton growers who are situated in the Sigatoka River valley will be issued with seed from New Guinea Kidney cottons during the season 1928–29. Seed from the increase plots of K11 will be kept in the vicinity of the Experimental Station. K8 will be given out to a community at the head of the river, K3 type to a community situated centrally between two ranges, while K1 is to be given to those who are situated between the Station and the mouth of the river. Sea Island cotton is to be neither grown not ginned in the Sigatoka district, and an Inspector who has recently been appointed for the purpose will insure that all the Sea Island cotton of the district has been uprooted and burnt before the new variety is planted.

Work on selections has of necessity been somewhat rushed, and seed is being distributed from increase plots a little prematurely. This has been brought about by the small demand for Sea Island cotton in the Home markets, and the urgent necessity to increase the output in order to bring down our overhead costs on the crop, and to hold the interest of native growers.

During September of last year, lint samples from four plants were sent to England for spinning tests and the results obtained were sufficiently encouraging to warrant a continuance of the selection work. The lint from all samples averaged $1\frac{3}{16}$ inches in length, and was valued at $14\frac{1}{4}$d. per lb (by the courtesy of Messrs. Wolstenholm & Holland).

Second year selections.—The four single plants, namely, K3–1, K3–2, K8–1 and K8–2, were planted in progeny rows and isolated from other cottons. Owing to the continuous rains and an indifferent seed bed, these plants made only moderately good germination. Careful roguing was carried out on all selections before they had reached the flowering stage. An analysis of these cotton samples was made and the ginning percentages

were taken from 100 gramme lots in each case. The result of these tests is given below:—

No.	Weight of 100 seeds.	Lint index.	Ginning per cent.	No. of bolls per lb	Mean lint length.	No. of plants.	Yield per plant.	Yield per acre.
	gms.				mm.		lb	lb
3–1	12·74	7·02	37	110·03	29	90	·566	821
3–2	14·07	7·47	36	82·3	31	76	1·236	1,794
8–1	14·23	7·96	33·97	83·9	28·5	117	·538	781
8–2	12·93	7·02	34·5	84·6	28·9	88	·795	1,154

Picking has not been completed on any of the above selections and it is estimated that the yields of all will be increased by at least 25 per cent.

K3–2 and K8–2 have kept remarkably true to type and are 100 per cent. free-seeded in both cases, while K3–1 and K8–1 have shown a slight deviation from their parents, both being inclined to produce conglomerate seeds. These two will be given out with the bulk seed during the coming season, and the former two will be sown on increase plots occupying an isolated position at the Experimental Station. They have supplied sufficient seed for ten and five-acre plots respectively.

Picking tests.—Picking tests made on progeny row selections at Koromumu resulted in the best picker reaching a total weight of 80 lb of seed cotton in a ten-hour day, but at the Station where the crop was somewhat lighter the highest tally per day was 60 lb, as against 27 lb on a moderately good crop of Sea Island.

Sea Island.—The seed from six plants selected last year was planted out in progeny rows on an isolated plot at Lawaqa, and the seed obtained from the two best rows (S17 and S25) was planted around them on increase plots. Unfortunately, the portion of the field upon which the selected plants were sown was slightly lower than the remainder and consequently during the five months of heavy and continuous rains the plants suffered badly from wet feet, and their growth was stunted to such an extent that it was decided to discontinue with the selection work and to issue seed for propagation next year from the bulk lot only. This will be given out to a few good cultivators who occupy isolated positions in the Lautoka district, and should it be decided to continue with the growing of the Sea Island variety in this Colony, the above mentioned seed would form the nucleus for further selection work in the coming season.

Varietal tests.—The tests were conducted on similar lines to those indicated in my last report, the only difference being that the area set aside for the purpose was divided into quarter-acre instead of half-acre plots in order to make room for a few more varieties. Eight plots of five of the main varieties, each measuring one-fortieth acre, were arranged on the chess-board system as a check against soil variation.

Sea Island.—Up to the present date Sea Island has given the highest yield. It reached maturity earlier than the Kidney types and all pickings have now been completed on it. During May 25 per cent. of the crop was damaged by rain.

Kidney Hybrids (from New Guinea).—These hybrids and the local Kidney reached maturity at a much later date than any of the other varieties. Pickings have not yet been completed from any of the Kidney types and it is estimated that the yield from all the plots will be increased by at least

25 per cent. The bolls opened well and the lint which was of moderately good quality was easily picked.

Sakel.—Both Egyptian and Sudan strains were badly attacked by *Bacterium malvacearum*, which, together with the late rains, caused then to shed very badly. The variety is not considered to be suited to the local climatic conditions.

Tanguis.—This variety was also attacked by *Bacterium malvacearum*. It put on a large crop which it shed immediately after flowering. All plants put on an excess of wood and had to be cut back, and on this account they were later in reaching maturity than would otherwise have been the case. There is another picking to be gathered from the top crop which should increase the yield of all the plots by at least 30 per cent.

Meade.—Meade was attacked by *Earias fabia* early in the season. It matured during the wet months and bolls failed to open well. It is considered unsuitable for this climate and further experiment with it will be discontinued.

RESULTS OBTAINED FROM VARIETAL TESTS.

Plot No.	Area.	Variety.	Date sown.	First picking date.	No. of cultivations.	Yield per acre.
						lb
1	¼	Sdn. Sakel.....	7/11/27	25/4/28	5	298
2	„	Sea Island	7/11/27	5/4/28	5	790
3	„	Tanguis	7/11/27	24/5/28	6	412
4	„	Egp. Sakel	8/11/27	1/5/28	5	274
*5	„	K8	10/11/27	24/5/28	6	1,012
6	„	K3	8/11/27	4/6/28	4	790
7	„	Meade	8/11/27	16/4/28	4	518
8	„	K1	11/11/27	4/7/28	5	728
9	„	Tanguis	11/11/27	5/5/28	5	346
10	„	K8	11/11/27	3/5/28	4	772
11	„	Meade	11/11/27	27/4/28	5	504
12	„	Sdn. Sakel	10/11/27	20/4/28	4	270
†13	„	Kidney Ratoon .	20/11/26	6/7/28	5	710
‡14	„	Kidney Ratoon .	20/11/27	13/7/28	4	1,000
15	„	K3	10/11/27	20/4/28	5	796
16	„	Tanguis	9/11/27	5/5/28	5	670
17	„	K1	9/11/27	12/7/28	4	696
18	„	Sea Island	9/11/27	5/4/28	4	1,151
19	„	Egpt. Sakel	9/11/27	12/4/28	4	396
20	„	Sea Island	9/11/27	5/4/28	4	1,228

* All plants in this plot were topped during the second week in April. There is another heavy picking to be reaped.

† This plot was ratooned to ground level and has another light picking to come off it.

‡ Pruned to 3 ft. 6 in. of ground level and a light picking yet to come off.

CHESSBOARD PLOTS 21 AND 22—AVERAGES FROM EIGHT 1/40-ACRE PLOTS.

Variety.	Area.	Date planted.	Date of first picking.	Cultivations.	Yield per acre.
					lb
Sudn. Sakel ..	2	6/12/27	3/5/28	5	245
Sea Island ...	„	6/12/27	5/5/28	5	812
Egpt. Sakel ..	„	6/12/27	5/5/28	5	247
K3	„	6/12/27	5/7/28	5	865
Tanguis	„	6/12/27	6/7/28	5	474

RESULTS OF WEEKLY FLOWER COUNTS MADE ON TWO AVERAGE PLANTS OF ALL VARIETIES.

Plot.	Variety.	Plant.	Weeks.	Flower shedding due to tip worm.	Flower shed from other causes.
				Per cent.	Per cent.
1	Sudn. Sakel	1	30	·08	28·0
		2	30	1·20	42·4
2	Sea Island ..	1	30	..	16·3
		2	30	·05	15·0
3	Tanguis	1	24	..	47·5
		2	30	..	70·0
4	Egpt. Sakel	1	30	·19	36·2
		2	30	·27	38·8
5	K8	1	10	..	5·2
6	K3	1	30	..	21·6
		2	30	..	20·8
7	Meade	1	32	2·	22·3
		2	32	1·4	23·6
8	K1	1	30	·23	23·
		2	28	..	20·1
13	Local Kidney ...	1	14	·22	12·
		2	14	..	8·2
18	Sea Island	1	32	·11	23·1
		2	32	..	17·5

The above results are fairly significant. Shedding caused by Pink Boll Worm was slight. It attacked the local Kidney variety more than it did other varieties.

Time of planting and spacing tests.—The above experiment was carried out on similar lines to those described in my previous report. Three quarter-acre plots, one of each being planted during the middle of November, December and January, were planted with rows six feet apart, and an additional three were planted on the same dates with rows five feet apart. Plants were thinned out to the following spacings:—A, 2 ft. 3 in.; B, 3 ft. 6 in.; C, 4 ft. 6 in.; and D, unthinned. The results obtained are not considered to be significant. The unthinned rows gave the best yield, but had the whole plot been planted with unthinned rows it is thought that a large percentage of boll rot would have been brought about, which would probably have reduced the yield by more than half, as it was, the unthinned rows had spaced ones on either side of them which allowed the sun to penetrate, and the percentage of boll rot on them was not particularly heavy.

Row.	Spacing.	Date planted.	Number of plants.	Yield per acre.	Means.
		PLOT No. 23.			
				lb	lb
1	5 ft. by 3 ft. 6 in. .	16/1/28	45	143	123·5
2	Unthinned	,,	660	260	214·5
3	5 ft. by 2 ft. 3 in. .	,,	65	169	130
4	5 ft. by 4 ft. 6 in. .	,,	35	78	68·2
5	Unthinned	,,	880	169	..
6	5 ft. by 4 ft. 6 in. .	,,	36	78	..
7	5 ft. by 2 ft. 3 in. .	,,	66	143	..
8	Unthinned	,,	1,210	273	..
9	5 ft. by 4 ft. 6 in. .	,,	39	65	..
10	5 ft. by 2 ft. 3 in. .	,,	69	78	..
11	Unthinned	,,	660	156	..
12	5 ft. by 3 ft. 6 in. .	,,	39	52	..
13	5 ft. by 3 ft. 6 in. .	,,	48	104	..
		PLOT No. 24.			
1	5 ft. by 3 ft. 6 in. .	16/12/27	46	143	156
2	Unthinned	,,	1,265	260	364
3	5 ft. by 2 ft. 3 in. .	,,	64	208	294·6
4	5 ft. by 4 ft. 6 in. .	,,	35	143	198·25
5	Unthinned	,,	1,410	481	..
6	5 ft. by 4 ft. 6 in. .	,,	36	221	..
7	5 ft. by 2 ft. 3 in. .	,,	65	247	..
8	Unthinned	,,	1,100	481	..
9	5 ft. by 4 ft. 6 in. .	,,	39	208	..
10	5 ft. by 2 ft. 3 in. .	,,	68	429	..
11	Unthinned	,,	766	234	..
12	5 ft. by 4 ft. 6 in. .	,,	38	221	..
13	5 ft. by 3 ft. 6 in. .	,,	48	169	..
		PLOT No. 25.			
1	5 ft. by 3 ft. 6 in. .	16/11/26	49	572	533
2	Unthinned	,,	654	7677	1,014
3	5 ft. by 2 ft. 3 in. .	,,	74	702	728
4	5 ft. by 4 ft. 6 in. .	,,	40	468	663
5	Unthinned	,,	604	1,027	..
6	5 ft. by 4 ft. 6 in. .	,,	39	481	..
7	5 ft. by 2 ft. 3 in. .	,,	68	676	..
8	Unthinned	,,	498	1,339	..
9	5 ft. by 4 ft. 6 in.	,,	39	910	..
10	5 ft. by 2 ft. 3 in. .	,,	68	606	..
11	Unthinned	,,	544	923	..
12	5 ft. by 4 ft. 6 in. .	,,	40	793	..
13	5 ft. by 3 ft. 6 in. .	,,	45	494	..
		PLOT No. 26.			
1	6 ft. by 3 ft. 6 in. .	16/1/28	44	231	231
2	Unthinned	,,	1,112	297	418
3	6 ft. by 2 ft. 3 in.	,,	64	253	249·3
4	6 ft. by 4 ft. 6 in. .	,,	35	187	183·3
5	Unthinned	,,	436	495	..
6	6 ft. by 4 ft. 6 in. .	,,	38	198	..
7	6 ft. by 2 ft. 3 in. .	,,	55	253	..
8	Unthinned	,,	802	462	..
9	6 ft. by 4 ft. 6 in. .	,,	37	165	..
10	6 ft. by 2 ft. 3 in. .	,,	60	242	..
11	6 ft. by 3 ft. 6 in. .	,,	45	231	..

Row.	Spacing.	Date planted.	Number of plants.	Yield per acre.	Means.
				lb	lb
	Plot No. 27.				
1	6 ft. by 3 ft. 6 in. .	16/12/27	41	154	253
2	Unthinned	„	719	627	715
3	6 ft. by 2 ft. 3 in. .	„	44	198	370
4	6 ft. by 4 ft. 6 in. .	„	35	176	282
5	Unthinned	„	765	649	..
6	6 ft. by 4 ft. 6 in. .	„	38	363	..
7	6 ft. by 2 ft. 3 in. .	„	68	363	..
8	Unthinned	„	800	869	..
9	6 ft. by 4 ft. 6 in. .	„	41	308	..
10	6 ft. by 2 ft. 3 in. .	„	69	550	..
11	6 ft. by 3 ft. 6 in. .	„	44	352	..
	Plot No. 28.				
1	6 ft. by 3 ft. 6 in. .	16/11/27	54	847	896·5
2	Unthinned	„	865	1,628	1,672
3	6 ft. by 2 ft. 3 in. .	„	71	1,144	1,239·3
4	6 ft. by 4 ft. 6 in. .	„	38	891	924
5	Unthinned	„	788	1,595	..
6	6 ft. by 4 ft. 6 in. .	„	39	913	..
7	6 ft. by 2 ft. 3 in. .	„	73	1,276	..
8	Unthinned	„	632	1,793	..
9	6 ft. by 4 ft. 6 in. .	„	44	968	..
10	6 ft. by 2 ft. 3 in. .	„	67	1,298	..
11	6 ft. by 3 ft. 6 in. .	„	47	946	..

Cotton crosses.—Various crosses made during last season at the Station, together with some kindly sent out for trial by Dr. Bancroft of Queensland, were planted out in single lines on a quarter-acre plot set aside for the purpose. All of the Hybrids sent over from Queensland were a complete failure. Those which were not killed off by "black arm" were severely infected with Jassid and produced practically no crop. A brief description of the other crosses is given hereunder.

Acala X Sea Island.—In habit of growth it was somewhat similar to that of Sea Island. The leaves were mostly smooth, about one plant in five possessed Acala characters with slightly hirsute leaves. The flowers resembled those of Sea Island, but the corolla was a paler yellow and the guide marks at the base were much less vivid. The seeds had a heavy greenish fuzz. Bolls were large and about 25 per cent. five-locked. The lint which was fine and silky averaged 38 mm. in length.

Meade X Acala.—These hybrids resembled Acala in habit of growth. The leaves were broad, dull green in colour and very hirsute. The flower a pale yellow with no basal colouration or guide marks opened fully. Seeds were covered with a short white fuzz which gave them a grayish appearance. The fuzz was less dense than that of Acala and the cotton should be a fairly easy ginner. Bolls were very large and about 27 per cent. five-locked. Lint averaged about 35 mm long and was of good quality and free from nep.

Sea Island X Acala.—The plant resembled Sea Island, but leaves were much broader and of a dull green colour and non-hirsute. Flowers were pale yellow and showed very slight brownish markings at the base of the petals which did not vary. Bolls were three, four and five-locked. The

seeds possessed a bright green fuzz and the lint was creamish brown in colour, silky in texture and the staple measured 30 mm.

Sea Island X Meade.—These plants showed slight Jassid resistant properties, and resembled Sea Island in habit of growth. Leaves were smooth, very broad and a dark green. Plants were uniform. Flowers pale yellow with slight basal markings. The bolls were three, four and five-locked (mostly four-locked). The seed had a large white tuft at the apex and was of a chocolate colour. It was slightly larger though very similar to Meade. The lint very silky sparce, but difficult to distinguish from Sea Island and measured 52 mm long.

PLOT NO. 29.

Variety.	Weight of 100 seeds.	Lint index.	Ginning.	Mean staple length.	No. of plants.	Yield per line.	Calculated yield per acre.
			per cent.	mm.		lb	lb
Sea Island .... X Meade	13·03	3·47	22·5	52	44	51	2,103·5
Acala X	10·95	7·83	29·5	38	9	10	2,016·4
Meade X	11·31	7·44	32·5	35	93	51	994·62
Caravonica from Noumea	16·57	7·7	32·7	28·6	3	..	1,815

Time of flowering and bolling averages.—Four plants from each variety were labelled and daily observations were made. Five squares on each plant were marked by coloured ribbons, and the results given below are the averages taken from twenty marked squares in each variety:—

Variety.	Planting to squaring.	Squaring to flowering.	Flowering to maturity.	Remarks.
	Days.	Days.	Days.	
Sdn. Sakel	37	21	52	.....
Sea Island	37	21	63	.....
Tanguis	37	28	82	Topped during April.
Egp. Sakel	36	21	52	.....
K8 .....SI K	42 104	25 52	59 80	There were two types—Sea Island and Kidney type.
K3	102	55	75	.....
Meade	36	17	49	.....
K1	101	60	83	.....
Kidney Ratoon ..	128	31	85	128 days from date of ratooning.

Pests and diseases.—*Jassid* was most prevalent during the months of March, April and May, but disappeared with the advent of dry weather and most of the varieties which had suffered from it made a rapid recovery. Tanguis was resistant.

Pink Boll Worm (*Platyedra gossypiella*).—During the season under review very little damage was caused by this pest. It was most probably kept in check by parasites. It was more prevalent on the local Kidney than on any of the other varieties, but only about 3 per cent. of the seed cotton was injured by it.

Cotton stainers (*Dysdercus insularis*).—Until the latter part of the season stainers were kept in check by hand collection. Every three or four days small boys were sent along the rows with kerosene tins containing half a gallon in equal part of kerosene and water, and into these tins the stainers were shaken from the branches.

Experiments were tried out with different types of Tanglefoot on Kidney Hybrid cotton (K8 type, which is almost a tree cotton). That which was imported from the United States of America was found to be the best; in in that it prevented all stainers that were in the nymph stage and unable to fly from reaching the cotton and only quite a small number of adults were found on the bolls, but it is too expensive to be advocated on a commercial scale.

Trials were made with resin, local gums, linseed oil, &c. Some of these mixtures acted quite well for the first week or so, but soon lost their tenacity.

Harlequin bug (*Tectacoris lineola*).—These pests were also kept in check by hand collection and did not at any time reach major proportions.

Fruit fly (*Dacus passiflorae*).—Despite a careful search throughout the season, the fruit fly could not be found on any of the varieties.

Tip worm (*Earias fabia*).—The incidence of the pest was light and affected Meade more than it did other varieties.

Black arm (*Bacterium malvacearum*).—This disease first made its appearance on Tanguis and caused a number of the plants to die back. It was later found on both strains of Sakel. Other varieties were not affected by it a great deal, but traces of it were found on a few plants from all varieties.

Future prospects.—Although the two past seasons have been very discouraging, and growers had at one time lost all interest in cotton growing, the prospects for the future development of the industry appear to be much brighter, and native growers of this district are quite keen to obtain seed of the new Kidney variety. It is anticipated that between 700 and 800 acres will be planted with it during the coming season, 1928–29. The estimated acreage for all other districts is 2,000 acres which will be planted with Sea Island.

Programme for 1928–29.—In the forthcoming season most of the time will be devoted to plant selection and breeding work with new Kidney Hybrids, and many of the varieties grown in the varietal tests last season will be done away with. Spacing tests will be discontinued with Sea Island cotton. Experiments will be carried out with various methods of ratooning Kidney types, together with spacing and topping experiments.

Conclusion.—In conclusion I should like to express my gratitude to the Superintendent of Agriculture and the Government Cotton Inspector for much appreciated and helpful co-operation by them, which greatly assisted operations on the Station. Also to my two field assistants, Messrs. H. V. Petley and C. M. Dass, who have both carried out their work very satisfactorily.

NOTES ON PASTURE PLANTS IN FIJI.

By J. D. Tothill, D.Sc., Superintendent of Agriculture.

During the last two years the Government Chemist has been engaged from time to time upon an analysis of pasture plants known to do well in this Colony. The work has gone far enough to enable conclusions to be drawn, but as the publication of a bare table may not be very helpful I will endeavour to explain the way in which this table of analyses can be turned to practical account. The table will be found at the end of this article, and for the sake of comparisons I have added an analysis of two of the finest forage plants known outside the tropics, namely, lucerne and meadow fescue, the figures for these being taken from the admirable text book on feeds and feeding by Henry and Morrison.

To take an example, the table shows that in 100 pounds by weight of fresh green *Paspalum dilatatum* there were 76·81 pounds of water, 2·51 pounds of protein, ·36 pounds of fat, 6·9 pounds of crude fibre, 11·02 pounds of carbohydrates, 2·2 pounds of ash, ·1 lb of lime and ·13 pounds of phosphoric acid.

The lime and phosphoric acid are necessary for the production of bone, but need not concern us in this article. The ash, which is that part of the grass that cannot be burned after a long exposure to a hot flame, contains other essential mineral ingredients without which animals cannot live for long but which need not concern us at this time. Crude fibre is incapable of digestion and though useful as roughage has no value as a food ingredient. Most forage plants consist chiefly of water which helps to make them succulent and palatable but which is not, strictly speaking, an essential food ingredient. The remaining items of protein, fat and carbohydrates are the important ones from a dairyman's point of view.

Protein is, without doubt, the most important of these three classes of foods. The dry material in animal bodies—apart from minerals and fats—consists almost wholly of proteids and they are an essential constituent of all living cells whether plant or animal. An animal could exist for a protracted period without carbohydrates or fats, but proteids are essential to life and growth. They contain not only carbon and hydrogen and oxygen but sulphur and nitrogen, and some of them contain phosphorus. They have a very complex chemical structure and, while they can be modified, they cannot be manufactured by the processes of animal metabolism. In eggs we find the vegetable proteids of the fowl's diet modified to albumen in the white and other proteids in the yolk, while in milk the vegetable proteids have been modified and returned, principally in the form of casein—the part of milk which produces the curd.

Fat is a term used to include all oily substances in the forage plant. While not as essential to life as the proteid elements of food, they share with carbohydrates the function of supplying heat and energy when, after absorption, their carbon and hydrogen element are slowly oxidised in the animal's body. In the vegetable kingdom fats occur chiefly in seeds. Chemically they are glyceral salts of fatty acids. They are soluble in ether and may be changed into soaps by treatment with alkal's. They are easily assimilated and may be stored in the form of fatty tissue (chiefly as glyceral stearate in cows) or secreted as in the butter fat of milk (glyceral butyrate).

Carbohydrates are the most abundantly produced food in all plants, including these forage grasses and legumes. They are composed of carbon, hydrogen and oxygen as are fats and they furnish heat and energy as fats do, but the elements are combined in a different way and in different pro-

portions and are subject to different digestive processes when eaten by animals. This class of food is manufactured in the leaves by the chlorophyll or green colouring matter from the carbon dioxide of the air and the water of the sap in the presence of sunlight. It circulates through the plant as soluble carbohydrates or sugars, is stored in seeds, roots or stems as insoluble carbohydrates or starches. After digestion these are stored in small amounts as muscle, sugar or glycogen or are transformed and stored as fats or appear in milk as maltose (milk sugar) or as transformed butter-fat.

As a result of a long series of experiments conducted in many countries it has been found that a dairy cow weighing 1,000 lb requires for the best results a definite quantity per day of each of these ingredients in the food ration. If she gives no milk whatever, she will require what is called a maintenance ration and for each pound of milk containing 4 per cent. of fat she will require an additional ration.

In the case of a 1,000 lb cow producing 25 lb of milk testing 4 per cent. fat, the digestible nutrients required per day are stated by Henry and Morrison to be as follows:—

	Protein. lb	Carbohydrates. lb	Fat. lb
For maintenance	·77	7·7	·11
For 25 lb of 4 per cent. milk . ..	1·35	6·0	·52
Total ..	2·12	13·7	·63

If a cow has nothing to eat but para grass and eats 100 lb of it per day, which is a fair average allowance, she will, according to an average of the Government Chemist's analysis, take in 2·19 lb of protein, 10·91 lb of carbo-hydrates and ·32 lb of fat. Thus it is seen that she gets about the right quality of protein, not quite sufficient carbo-hydrates and only half the proper amount of fat. This is what is called an unbalanced ration in which the nutritive ratio is a little too narrow.

The nutritive ratio is obtained by dividing the proteins (2·19 lb in this case) into the sum of the heat equivalent of the fat plus the carbohydrates; for the purpose of this calculation the fat is multiplied by 2·25 because fat is about 2·25 times as good a fuel as are carbohydrates. Accordingly, the nutritive ratio for para grass is ·32 (fat) by 2·25 (heat equivalent) plus 10·91 (carbohydrates) ÷2·19 (proteins) which works out at 4·9 and the ratio is said to be 1 to 4·9 or 1 : 4·9. A good ration for a dairy cow is somewhere between 1 : 5 (narrow) and 1 : 8 (wide) so that the ratio for para grass is a little too narrow for best results. Moreover, the water and crude fibre content is high for this grass and therefore an unusually large quantity of this feed would be needed to supply a cow's needs.

If, on the other hand, a cow received an exclusive diet of sensitive plant (*Mimosa pudica*) she would, after consuming 100 lb in the 24 hours, have consumed 4·4 lb of protein which is more than twice as much as she requires, 12·35 lb of carbohydrates which is slightly short of the requirement and ·71 of a lb of fat which is somewhat more than she can use. Although the nutritive ratio of this diet 1 : 3·17 is too narrow for best results yet the figures show the very high value of the plant to dairymen in this Colony.

If we feed a mixture of half para grass and half sensitive the results work out as follows:—

	Protein. lb	Carbohydrates. lb	Fat. lb	Nutritive ratio.
50 lb Mimosa . ..	2·2	6·2	·35	..
50 lb Para grass ..	1·1	5·45	·16	..
	3·3	11·65	·48	1 : 3·8

This gives our cow too much protein, with insufficient carbohydrates and fat.

By decreasing the proportion of sensitive plant the results are obtained as follows:—

	Protein. lb	Carbohydrates. lb	Fat. lb	Nutritive ratio.
25 lb Mimosa . .	1·1	3·1	·17	. .
75 lb Para grass . .	1·7	8·2	·24	. .
	2·8	11·3	·41	1:4·3

As in the case of the last mixture a cow would obtain slightly too much protein, close to the right quantity of carbohydrates and not quite enough fat, but on the whole the mixture would be fairly satisfactory.

This mixture can be improved by the addition of green ripe corn or maize that could be used to great advantage in June, July and August when para grass and sensitive plant are generally producing little herbage. A mixture suited to many dairy farms in this Colony would be:—

	Protein. lb	Carbohydrates. lb	Fat. lb	Nutritive ratio.
50 lb green ripe corn	·75	10·5	·4	1:15·2
25 lb para (pasture)	·55	2·7	·08	1: 5·24
25 lb Mimosa (pasture)	1·1	3·1	·17	1: 3·15
	2·3	16·3	·65	1:7

This mixture is a particularly good one and should produce more butter-fat in the winter months than does para grass alone in the wet season.

On those farms where Mimosa has not yet been introduced, a fairly satisfactory mixture for the dry months would be:—

	Protein. lb	Carbohydrates. lb	Fat. lb	Nutritive ratio.
50 lb of green ripe corn	·75	10·5	·4	15·2
50 lb of para (pasture)	1·1	5·45	·16	5·28
	1·85	15·95	·56	1:9·3

In order to use maize—dent corn is the best—as a soilage crop, that is to say, as a crop that is cut by hand from day to day and fed to the cows, it would be necessary to time three sowings so that the crops would ripen in June, July and August successively because the value of the crop is not nearly as good unless fed when in the ripe stage.

Another grass that shows up well in the analyses is *Paspalum dilatatum*. It is a better complete food than para grass because it supplies a larger amount of fat. It is, in fact, the best individual grass from a nutrient point of view on the table of analyses. This grass does well on the hill lands of Tailevu and when once properly established appears to compete favourably with the bush *Clidemia*. It is suggested, therefore, that each producer in this district would find it to his advantage to reclaim, we will say, two acres of hill land per annum and hand plant it to this excellent grass. Initial weeding would have to be done systematically, but once the plants had formed a cover the cost of maintenance would be very small. In ten years time such a practice would result in a substantially increased cream cheque for each farm.

The table which follows is worth careful study by dairy farmers. It represents a large amount of work on the part of the Government Chemist and will form a useful permanent record.

For comparison I have added analyses of dent corn, lucerne and meadow fescue and, for ease of reference, have included the essential content of the daily ration of a cow weighing about 1,000 lb producing 25 lb per day of milk containing 4 per cent. fat. As such a cow would eat about 100 lb of green food per day, the figures given in the columns can be compared directly with those in this column.

Analyses made by the Government Chemist of some Fiji Pasture Plants.

(Calculated on the fresh condition as newly picked.)

Name of plant.	% of protein.	% of carbo-hydrates soluble N free extract.	% of fat (ether extract).	Nutri-tive ratio.	% of water.	% of of crude fibre.	% of ash.	% of lime (cao).	% of phos-phoric acid P2 05.
Paspalum dilatatum	2·51	11·02	·36	1:4·9	76·81	6·9	2·20	·10	·13
Paspalum conjugatum (local name, Thurston grass)	1·12	12·32	·35	1:11·7	75·9	7·53	2·58	·12	·18
Do. (a second analysis)	1·81	14·66	·41	1:8·6	71·5	8·71	2·91	·15	·19
Panicum barbinode—Para grass, sample 1	2·00	8·19	·14	..	79·7	7·9	2·07	·06	·15
Do. sample 2	2·66	11·61	·43	1:4·8	71·5	11·68	2·11	·09	·08
Do. sample 3	1·91	12·93	·39	..	73·2	9·2	2·37	·10	·17
Do. average of samples	2·19	10·91	·32	1:4·9	..	..	..	..	..
Panicum maximum—Guinea grass	1·51	7·6	·28	1:5·4	78·95	8·76	2·85	·19	·19
Stenotaphrum americanum, Buffalo grass, samp. 1	·99	6·92	·38	..	82·03	7·86	1·82	·091	·16
Do. samp. 2	1·21	6·43	·41	..	83·61	7·45	1·76	·080	·13
Eleusine indica—Tropical Crowfoot	1·91	11·58	1·1	..	75·4	7·61	2·40	·07	·2
Eriochloa subglabra, Carib grass growing at Nasinu	2·3	7·3	·7	..	81·8	6·0	1·9	..	..
Pennisetum—Mission grass growing at Nasinu	1·08	4·7	·4	..	89·0	3·4	1·4	..	..
Mimosa pudica—Sensitive plant, sample 1	3·91	14·96	·72	..	63·4	15·11	1·9	..	..
Do. sample 2	3·80	13·90	·60	1:39	65·7	14·4	1·6	..	..
Do. sample 3 (ends of young shoots only)	5·50	8·20	·80	..	74·9	9·0	1·6	..	..
Do. average of 3 samples	4·40	12·35	·71	1:3·7	..	..	..	..	..
Desmodium heterophyllum (a few plants are established at Suva)	2·8	11·01	1·05	..	74·69	7·66	2·81	·21	·31
Micania scandens (mile-a-minute)	·77	13·80	1·55	..	76·85	5·04	1·99	·09	·11
*Medicago sativa—Lucerne	4·5	10·4	1·0	..	74·7	7·0	2·4	·35	·25
*Festuca pratensis—Meadow fescue	3·0	14·0	1·0	..	69·5	10·1	2·4	..	..
*Green dent corn (in condition to feed as a soilage crop)	1·0	12·8	·4	1:13·7	..	..	..	..	..
*The ration for a 1,000 lb cow producing 25 lb of milk containing 4 per cent. butter-fat should contain	2·12 lb	13·7 lb	·63 lb	1:7	..	..	..	..	..

* From Henry and Morrison.

LANTANA BUG "TELEONEMIA LANTANAE, DISTANT."

Report by the Government Entomologist to Superintendent of Agriculture on a mission to Honolulu to obtain the Lantana Bug "Teleonemia lantanae, Distant."

NOTE BY THE EDITOR.

ON page 10 of the last number of this *Journal* a note was printed concerning the proposal to introduce the insect mentioned in the title of this article. As the insect has now been successfully introduced, it seems desirable to bring all the information concerning this project together so that it will be available for future reference. The initial step was taken as a result of a Council Paper written by the Superintendent of Agriculture and, as this Paper is short and may not have been seen by the planting community generally, it is reprinted here for reference.

It is too early as yet to say what value, if any, the *Teleonemia* will have in this Colony, but Mr. Simmonds' report shows that a sufficient number have been introduced to give the insect every possible opportunity of increasing rapidly.

A reprint of the Council Paper No. 35 of 1928 is as follows:—

Some years ago when lantana had become a very serious weed in the Colony of Fiji Mr. Jepson, then Government Entomologist, was authorised to proceed to Hawaii in order to examine the work that had been done by the Hawaiian authorities towards controlling the same weed in that territory by the introduction of insect enemies. As a result of his inquiries he successfully introduced a small fly *Agromyzae lantanae.*

A few years later the then Acting Government Entomologist, Mr. Simmonds, introduced two butterflies falling under the family *Lycaenidae,* namely, *Thecla echion* and *T. bazochi,* the larvæ of which were known to feed exclusively upon lantana and particularly upon the flowers.

The Government Entomologist now reports that the position in Fiji at the present time is as follows:—

"*Thecla bazochi* is now generally distributed around Suva and Levuka, but is not locally as abundant as shortly after its introduction.

Thecla echion was liberated on Taveuni, but whether established is uncertain.

Agromyza lantanae is everywhere."

The following summary of the position in Hawaii as at September, 1924, is taken from Mr. O. H. Swezey's Bulletin No. 16 of the Hawaiian Sugar Planters' Association. Several insects introduced into Hawaii for the purpose of controlling lantana between the years 1902 and 1905 were—

> generally spread throughout the islands of the group and have continued their work in more or less checking the lantana, the effectiveness depending on climatic and, perhaps, other conditions in the various regions. In some places this is due to the combined work of the insects, successive prolonged dry periods, and to the presence of cattle. Where lantana is cleared from the land for grazing or agricultural purposes, it does not usually again take possession if the land is abandoned and allowed to revert again to natural growth of weeds or bush. Instead of lantana reoccupying such lands, several other kinds of shrubs or trees have taken possession, some of them much more difficult to eradicate than was the lantana.

From this statement and from what I personally saw of lantana in Hawaii in December, 1924, it seems clear that the degree of control of lantana in

Fiji at the present time is considerably less than that in Hawaii. The question therefore arises as to whether further steps could not be taken to improve the local position. There is a small insect in Hawaii called *Teleonemia lantanae* belonging to the family *Tingitidae* that feeds upon the foliage of lantana and becomes so numerous occasionally as to completely defoliate the plants. Steps have not been taken hitherto to introduce this insect on account of the possibility of its feeding on some other plant of economic importance. As it has now been established for a number of years in Hawaii a letter was sent recently to Mr. O. H. Swezey, the entomologist to the Hawaiian Sugar Planters' Association, asking him to be so good as to give an outline of the present status of this insect in the territory under his control. His reply, dated April 29th, 1928, is as follows:—

> As to your inquiry about the lantana bug, *Teleonemia lantanae*, having any objectionable habits. Here in Hawaii it has not been known to breed on any other plant than lantana. It often infests lantana over great areas, and the young develop so abundantly on the under side of the leaves that their feeding destroys the leaves. The whole area of bushes will look as though dead. They are not dead, however, but their growth has been checked, and blooming prevented. Thus the bug is a factor in preventing seed production. When the infected leaves fall from the bush before the nymphs have matured, no doubt many of them die. Those that have matured migrate to other lantana areas. Often the adult bugs may be found scattered on many other plants, possibly feeding on them slightly, but such feeding is not of any consequence. They do not oviposit in anything but lantana. No infestations have been found on anything but lantana.
>
> If you are considering the introduction of this bug to Fiji I should say from the experience here, that it is entirely safe, and that it would be a factor in checking seed production. It would not kill off the plant however. Here, after the lantana has been defoliated by this bug, the bushes will have a dead appearance for a time, but eventually make a fresh, new growth. Of course, if it should be a long dry time, this new growth does not take place so soon, and there is some dying back of the tips of twigs.

In view of this statement from so reliable an authority I consider that it would be safe to introduce this insect into the Colony of Fiji.

Report by Mr. H. W. Simmonds.

Acting under instructions received I left Suva by the s.s. " Ventura " on 20th September, 1928, to proceed to Hawaii in order to obtain and endeavour to establish in Fiji the *Tingid* bug, *Teleonemia lantanae*, Dist., which had been introduced into that country by Koebele from Mexico in 1902, and which, it was hoped, would prove a valuable additional check upon the spread of the weed in these islands.

At Honolulu I was most kindly met by Mr. O. H. Swezey and Dr. Williams of the Entomological Staff of the Hawaiian Sugar Planters' Association. These officers and the officers of the Department of Agriculture and Forestry and also Dr. Illingworth of the Pineapple Growers staff did everything in their power to help me, constantly placing their motor cars at my disposal, driving me to various likely places to locate the insect that I desired and later, when located, assisting me to collect the quantity required for shipment.

Condition of the weed lantana in Hawaii.

The weed *Lantana camara* is generally distributed throughout Oahu, in many parts covering considerable areas. As a general rule it is stunted as compared to Fiji, but in the mountain valleys and other favourable parts seems as vigourous as is usual in this country. How far the general stunted appearance is due to insect attacks and how far to the drier climate I would

not like to say, I am, however, informed that it has disappeared from many areas where it was formerly abundant. Unfortunately, it has, in certain places, been replaced by other and even more noxious weeds, chief of which are *Acacia farnesiana* and guava, both present in Fiji.

At the time of my visit the weather was very dry and large areas of lantana were completely defoliated. Most of this defoliation was due to a recent attack of the bug *Teleonemia lantanae*, which is now being introduced into this country. The defoliation caused by this bug makes its attacks the most conspicuous of those caused by the insects introduced by Koebele in 1902 for the control of the weed.

Of the other insects introduced and established at that time two *Thecla agra*, a flower-eating butterfly, and *Agromyza lantanae*, a seed destroying-fly, have already been successfully established in Fiji, whilst *Thecla echion* was attempted on Taveuni but it is not yet known whether it is established on that island. In addition to the insect now being introduced three moths and a gall-forming fly have as yet not been attempted.

Whilst the recent work of the leaf *Teleonemia* was very much in evidence throughout the island of Oahu it was difficult to find it actually present, only two active outbreaks being discovered, with here and there a few odd scattered specimens. These two outbreaks were situated, one about 40 miles from Honolulu and, a large one, in a mountain gully about 28 miles away. In both of these places the bug was extremely numerous and I collected between 10,000 and 12,000 to bring away with me.

Action of bug on plant.

Both adults and nymphs suck the juices of the leaves and young stems and to some extent the flower buds. Older leaves, when attacked, become covered with pale spots due to the removal of the contained juices, whilst younger leaves generally develop a curled contracted look and, both old and young, dry up and drop to the ground. The attacks necessarily reduce the capacity of the plant to produce flowers and seeds, although not actually killing it.

The life history of the bug has not yet been worked out and the eggs are unknown, but the bugs bred freely in my cages, both in Hawaii and on the voyage to Fiji.

Of the lantana insects not yet brought to Fiji the *Crocidosema*, causing a certain amount of dieback, is probably the most valuable, but the gall fly is also conspicuous in its work. Both of these insects, however, by causing dieback of the terminals, lead to lateral branching and I am inclined to think are largely responsible for the matted growth of the plant in Hawaii as compared to Fiji, in which case they would hardly be desirable.

Collection and transport of bugs.

In order to transport the bugs to Fiji sixteen lantana plants had been kindly planted in tubs, in quarantine, by the officers of the Sugar Planters' Association. Those were placed into large cages, 2½ ft. by 2½ ft. by 6 ft. high, and insulated from ants.

As it was found that the bug would breed in the cages it was decided to adopt the method of loading principally adults, a total of 8,000 being collected, which were divided between the six cages, whilst a further 2,000 were placed in glass mason jars to be fed daily by hand on the voyage.

Both methods proved satisfactory so far as the transport of the bug was concerned and, on arrival in Suva, they were present in all stages and great numbers, 8,500 having been transferred by the 22nd with still more uncounted to come.

Arrival and liberation in Fiji.

Fiji was reached on November 1st at noon and that afternoon 500 of the adults, which had travelled in the mason jars, were liberated on Circular Road.

Next day two cages were prepared with local plants and loaded up with 1,550 adults, whilst a further 1,500 adults were released at Tamavua and Circular Road.

On November 7th, 1,150 nymphs were collected from the three cages which had been longest in use and transferred to local plants in another cage and the imported plants fumigated, the soil being afterwards dumped into the sea. The remaining cages were similarly treated ten days later, after the collection of the majority of the remaining nymphs.

Liberation.

In order to prevent the introduction of any undesirable insects all material for liberation was collected in the adult stage only, and from a white surface. It was placed in tubes of 100 to 200 and carefully gone over with a lens before being released.

A total of 4,000 adults have, up to date, been freed in the Suva district, viz., Samabula, 500; Reclamation, 150; Tamavua, 1,900; and Circular Road, 1,500. Colonies are now being prepared for liberation elsewhere in the group.

Recovery of bugs in field.

On November 19th newly hatched nymphs of the bug were observed at the Tamavua and Circular Road colonies, whilst they were also present in the breeding cages at the office. On November 22nd nymphs were numerous at Tamavua, but the Circular Road colony was less satisfactory.

Other parasites brought back at same time.

There are in Hawaii a number of other parasitic insects, mostly imported, many of which should be of value to this country and the introduction of certain of these was attempted on this occasion. Limited attention only, however, could be given to these, as it was necessary to ensure the success of the main objective.

House and Sarcophid fly parasites.

A quantity of material was collected in the hopes of obtaining parasites which would attack cow dung breeding *Diptera*. I was, however, unfortunate in that the material which I obtained proved to be mostly unparasitised, although as high as 80 per cent. parasitism of the horn fly, which breeds in cow dung and whose parasite also attack house flies, has been obtained. Mr. Fullaway of the staff of the Agricultural Department at Honolulu has, however, kindly promised to endeavour to get a pure culture of these on house-fly puparia and forward when available.

Banana Scab Moth (*Nacoleia octasema.*)

Although this moth does not occur in Hawaii, *Nacoleia* (*omoides*) *blackburni* on coconuts and bananas and five other species of *Omoides* are known,

all being heavily parasitised, and it was thought that some of those parasites would possibly attack *N. octasema*. The chief parasites are:—

1. An Ichnumonid .. .. *Cremastus hymeniae.*
2. A Braconid .. .. *Microbracon omiodivorium.*
3. A Chalcid . .. .. *Chalcis obscurata.*
4. A Tachinid .. ..

Egg parasites and occasional other *Ichnumonidae* are also bred from the same hosts.

I was unable to obtain the *Tachinid*, which had, however, at one place been numerous shortly before my visit.

Of the Chalcid I obtained about 25 and these in captivity were found to attack the pupae of *N. octasema* freely and also of the cotton pest *Sylepta derogata*. These will be liberated only if it can be proved that they will not attack *Ptychomyia* before liberation.

The *Braconid* was very numerous and about 200 were brought through. About 150 of these were liberated near Tamavua, the balance being used to try to breed in captivity. This proved unsuccessful as they became entangled in the webs spun by the *Nacoleia* and *Sylepta* larvae in the tubes and jars, so I liberated the balance in my garden, where I hope they may find sufficient *Hymenia fascialis* to establish themselves.

The *Ichnumonid, Cremastus hymeniae* is, however, the one most likely to prove of value and of these I was only able to bring 16 adults. Only two of these were males, and these were not observed to pair in the tubes. On arrival they were all placed in a big cage, with several bunches of bananas affected by the scab larvae. They became most interested, hunting over and around the bunches, but an accident necessitating opening of the cage, it is probable that some escaped. In any case none were bred through. This parasite has, in Hawaii, been bred from all six species of *Omoides*, also from 20 other lepidopterous larvae and is at times extremely numerous on *O. blackburni*.

I feel that *Cremastus hymeniae*, the *Tachinid* (the name of which I omitted to obtain) and the *Microbracon*, if not established, are all desirable. Mr. Swezey has kindly promised to endeavour to obtain the first for us when he comes across it in quantity. The fact that its principal host is a banana insect (as well as coconut) and its varied list of hosts and, that it is at times extremely numerous on *Nacoleia blackburni*, make it offer decided possibilities against *N. octasema*. There is also an egg parasite of *N. blackburni* which might be of value, but which I did not come across on this occasion.

Ladybird (Azya luteipes.).

About a dozen examples of this ladybird, which destroys *Lecanium* scales survived the journey and were liberated upon a patch of *Lecanium* in the office grounds.

Other Valuable Insects in Hawaii.

Nut Grass Enemies.

Two enemies to this pest are now established in Hawaii, one, a moth, being widely distributed and may prove to be the same as one in Fiji. I have not yet had an opportunity of comparing them and it appeared to be a little larger.

The second is a beetle and, at present, is confined to one or two small areas. It should eventually prove the more valuable of the two, as it is more destructive in its effects.

Rose beetles.

Considerable efforts are being made against this pest, and a *Tachinid* which attacks the adults is now being introduced.

SUMMARY OF POSITION ON 27TH NOVEMBER, 1928.

Teleonemia lantanae.—9,450 specimens of this bug have now been collected and transferred from the introduced material. These were dealt with as follows:—

1,075	sent to Suvasavu on 26/11/28.
160	liberated on Reclamation on 15/11/28.
500	liberated at Samabula on 14/11/28.
1,900	liberated at Tamavua on various dates.
1,550	liberated at Circular Road on various dates.
5,185	total liberated to date.

The balance are being used to breed in captivity, but a colony of 2,000 is being collected to take to Taveuni on 29th November, 1928.

2. I am of opinion that all my cages are now, so far as imported material is concerned, clean. One cage is, however, a contact, and that will be fumigated after the bugs are withdrawn as they become adult. When this is done I shall be able to report the actual numbers imported.

3. Owing to probable lack of food during my absence I propose to liberate a further number locally before I proceed to Taveuni.

Chalcis obscurata.—This was tested against *Ptychomyia*, and whilst, in one case, it appeared to have stung one, none have as yet bred through. It was, however, found that there was a considerable pupal parasitism, 20 to 25 per cent., of *Nacoleia octasema* from a dark winged local *Chalcid* and, as it was unlikely that a second species would materially increase this, it was decided to destroy the introduced one and this has been done.

VISIT TO TAVEUNI BY GOVERNMENT ENTOMOLOGIST.

By H. W. SIMMONDS, F.E.S., Government Entomologist.

THE main object of this visit (November 28 to December 10) was to liberate a Colony of the imported lantana insect *Teleonemia lantanae* in a suitable locality on Taveuni.

2. Headquarters were made at Waiyevo where there was a fine stand of lantana. It was found, however, that this area was isolated, the weed not extending southwards, whilst northwards it did not seem to go beyond Bucalevu.

3. I was informed that there were considerable areas about St. Heliers in the north and also from Ura southwards at the other end of the island. I decided to liberate the bugs at Ura, selecting a well-sheltered hollow at the back of the estate on the Selia Levu road, and this was done on Saturday afternoon, 1st December, 1928.

4. The colony, which consisted of 1,100 adults and 1,100, nymphs seemed to be in extremely good order when set free.

Scale Aspidiotus destructor.—Whilst waiting for the return of the "Makatea" careful search was made, over a limited area, for this pest. The native villages of Somosomo and Bucalevu were worked, as were the plantations as far south as Wairiki and a day was spent in the big bush. Particular attention was given to the various species of *Piper*, also to Kavika and Vutu, whilst bananas and coconuts were carefully watched. Nowhere was anything seen to suggest the presence of this pest on the island.

[NOTE BY THE EDITOR.—As the three plants mentioned are amongst the favourite food plants of this insect, it can, I think, be taken for certain that the scale has not yet reached Taveuni. Taveuni planters should therefore be particularly careful to prevent the landing of infected kava roots from Vanualevu in parts of which this scale is now extremely abundant.]

SOME EXPERIMENTS TO ASCERTAIN THE PART PLAYED BY FLIGHT IN THE DISPERSAL OF THE BANANA BORER COSMOPOLITES SORDIDUS IN FIJI.

By H. W. SIMMONDS, F.E.S., Government Entomologist.

AN INTRODUCTION BY THE SUPERINTENDENT OF AGRICULTURE.

IT is now generally recognised that the banana borer *Cosmopolites sordidus* is the most important pest of bananas in this Colony and that no steps of much importance can be taken toward improving plantations that do not provide for the control of this beetle.

The beetle breeds chiefly in the base of the old stumps and spreads in due course to the corms of the green trees in the same clump. In the campaign now being conducted for cleaning up the old plantations special stress is therefore placed in the destruction of the old stumps.

When it comes, however, to planting new areas it is advisable to use clean suckers, and at present there is no reserve of clean suckers from which to draw and no satisfactory method of eatablishing such reserves has been developed.

As a preliminary step one must know how long a clean nursery can be expected to remain free from beetles because it is no use to go to the trouble and expense of establishment if beetles find their way in within a few months.

The question as to how this beetle migrates is therefore of considerable importance to the banana grower, and with a view to obtaining some definite information on the point the Government Entomologist was asked to carry out certain experiments, the results of which he records in the following article together with the results of an earlier experiment carried out in 1921.

The experiments cannot be regarded as conclusive, but as far as they go appear to show that although the beetle flies, its migration by flight is practically negligible and that a clean nursery would become infected very slowly by beetles crawling in from neighbouring plantations.

ACCOUNT OF THE EXPERIMENTS.

The borer lays its eggs in tiny pits in the corm of the banana, the newly-hatched larvae boring into the heart of the corm. In this position they are almost immune to the action of either poison or fumigation. It is in this

way that eggs and young larvae are generally transported in the young suckers to new plantations and it is these transplanted larvae which cause the majority of the misses when planting up new land. If growers could be induced to pull up all affected suckers and burn them immediately they are observed, through failure to grow, to be attacked, they would, in my opinion, considerably increase the yield of their estates.

It is also by means of infected suckers that new areas become infected and it therefore becomes a question whether, provided clean suckers could be obtained, the beetle has other sufficient means of dispersal to quickly infect such new, clean areas. This leads to the question as to what part flight plays in the dispersal of the pest.

Flight.—The adult beetles have well-developed wings, but they undoubtedly travel on the estates mostly by crawling, and authentic records of flight are exceedingly meagre. The following are all I have been able to collect in Fiji:—

Date.	Locality.	Authority.
12–11–23.....	Specimen found on dining-table, Suva	G. H. V. Saunders.
2– 7–24.....	„ dining-table, Suva	C. T. McNamara.
*14–11–27.....	„ on electric light post, Suva ...	H. W. Simmonds.
*23–12–27.....	„ in kitchen, Suva	H. W. Simmonds.
22– 4–28.....	„ settled on head but lost, Suva .	G. H. V. Saunders.

* Both empty females.

McDonald states that between 1910-1914 he had had them bang against his mosquito gauze, perhaps a dozen times. The above records all lack something definite, but more satisfactory information is available elsewhere, as follows:—

Date.	Locality.	Authority.
12– 4–24.....	At Buderin, Queensland	F. W. Froggatt.
23–11–24.....	A male caught in flight at Valdora, Queensland	„
25–11–26.....	At Buderim a male flew onto a table	„

At La Brea in Trinidad one was actually captured in flight by F. W. Urich, whilst two others were taken at light.

These observations seem to leave little doubt but that the beetle does, on occasions, fly and the question as to what extent flight is a factor in the dispersal of the pest becomes of the utmost importance in trying to devise methods of control. If it can be shown that flight seldom takes place, then it would be possible, by using clean suckers and planting clean land, to obtain good crop returns before the pest reached the area in sufficient numbers to cause appreciable damage.

Experiments.—With these objects in view the following experiments were carried out:—

As far back as July, 1921, I carried out the first experiment in the back of the old Agricultural Department in Hercules Street. Suckers were obtained from heavily borer-infected Java, Cavendish and Lady's Finger plants. These were scrubbed and carefully examined, and of these 4 Java,

2 Lady's Finger and 3 Cavendish seemed to be free from the pest and were planted out. Within three months three of the Javas and two of the Cavendish showed by failure to grow and general yellowness, that, despite these precautions, borer was present. These were then dug up, when it was found such was the case and they were burnt. This burning was effective, destroying all borer present, the remainder going ahead well. When, during the following year, suckers were removed, no trace of borer could be detected. The land then passed from the control of the Department, some time after which the Lady's Fingers were removed. The Cavendish remained, however, and, as late as February, 1926, the main tree and one of its suckers produced twelve hand bunches. A year later, however, there was a marked falling off, borer was found to be present and the bunches were reduced to six hands. The above experiment demonstrated that the dispersal of the borer other than by infected suckers is slow, and that in its absence the plants yielded 100 per cent. increase.

Second Experiment.—This experiment was undertaken to try to find if flight was habitual or only occasional, the following method being adopted:—

On December 28th, 1926, 15 adult *C. sordidus* were placed into a flat tray, having upright sides, with about one inch of soil at the bottom. In order to make sure that the beetles could not get out by climbing, a ring of tanglefoot was placed round the top, whilst as a further precaution the whole tray was insulated by water covered with a film of oil. The trays were placed on a table in the big insectary and pieces of cut banana corm laid around upon the table to tempt them to leave the tin. This of course they could only do by flight.

For the first ten days the soil was kept moist, after which it was allowed to dry off. Whilst it was moist the beetles were very sluggish boring into the damp soil and remaining more or less in a mass during the daytime. As soon as it dried up, however, they came to the surface and crawled about, trying to climb the sides, but so far as could be seen no attempt to fly was made. They were also given a stick to be used as a jumping off place, but no attempt appeared to be made to use it and after 20 days the experiment was abandoned, all the beetles being still present in the tray. The weather conditions for this experiment were ideal, with many moist warm nights.

Field experiments.—It was then decided to carry out a field test to see if flight was, under natural conditions, a factor to be taken into serious consideration. Land was prepared at Mr. Calway's Nursery at Lami and about a hundred eyes placed in sand to obtain borer-free stock. This was so far successful that the proportion of infection was reduced to about five per cent. The cleared land had had bananas on it, and other badly-infected stools adjoined, whilst abandoned plantations occurred 50 yards and again 250 yards away. Borer was heavily present in the old plants around. It will thus be seen that there was an abundant supply of the pest to infect clean suckers, if such were planted in the neighbourhood.

The plan was to plant out thirty suckers in such a way that borer could only reach them by flight and a further thirty under normal conditions to act as a check. There was of course a possibility that the pest might be present in the soil and this would have to be taken into account in any infection which might be found to be present in the protected plants. As a precaution against any such being present the soil was fumigated where the protected plants were to be placed, with carbon-di-sulphide. I have reason, however, to consider this fumigation was ineffective as slugs and other organisms were found to have survived it.

As stated above, in order to obtain clean suckers, about 100 eyes were taken, carefully examined and set in sand by Mr. Calway. These were carefully gone over as soon as they were set and sixty, apparently sound ones, selected. Thirty of these were planted in large galvanised cylinders, bent over at the top rim and sunk, twelve sunk six inches and eighteen of them eighteen inches into the ground. Around the top of each cylinder, and under the protection of the inverted rim, a ring of tanglefoot was placed and renewed as occasion required. This, in my opinion, should effectively prevent any borer reaching the contained plants, except by flight. Beside each cylinder another clean sucker was planted, unprotected in any way, to act as a check. The plants were laid out in four plots planted as follows:—

Plot I ..	Planted March 8th, 1927 ..	6 protected,	6 checks.
Plot II ..	Planted April 29th, 1927 ..	8 ,,	8 ,,
Plot III	Planted May 11th, 1927 ..	12 ,,	12 ,,
Plot IV ..	Planted May 19th, 1927 ..	4 ,,	4 ,,

The plants were allowed to grow until the end of the normal wet season following, being dug up and examined on April 20th and 21st, 1928.

Result of experiment.—It was observed that (probably owing to the extreme paring which had been necessary to be sure that no borer was present) the original bud remained in most cases as a bulb, the plant growing above it, the original rootlets having formed at the neck of the bulb whilst the bulb itself had rotted and turned black. When dug out and examined the thirty protected plants showed 28 absolutely healthy. There were however two plants (Plot I, No. 2: and Plot II, No. 6) in which the original bulb, which was black and dead, showed signs of insect attack, but whether by borer introduced with the original sucker or later by scavenger I sould not say. In any case the growing plant was clean as the remaining 28 and it is certain no borer had reached any of these plants by flight.

The check plants.—One of these (Plot III. No. 9) was removed twenty days after planting owing to borer, undoubtedly present when the sucker was planted out. Six showed a similar condition to the two in the protecting rings, having had insect attacks, confined to the original decayed bulb only. Of the remainder, seven were found to have been attacked, whilst sixteen were absolutely clean.

Summary of results of experiment No. 3.—The details of the plots will be shown as an Appendix. Seven of the check plants definitely became infected; one other undoubtedly had borer when planted out, whilst of the seven doubtful cases (2 protected and 2 unprotected), which I at first thought showed traces of having had borer in the original bulb, I now think more likely to have been the work of other agencies, which would attack the bulb after death.

I am of opinion that these experiments show—

1. that flight as a factor in the spread of borer is practically negligible;
2. that the borer undoubtedly crawls, as was well known, but that such crawling is not nearly to the extent supposed, and that if clean suckers are used infection would be slow in reaching injurious proportions;
3. that it is most difficult to obtain borer-free suckers by mechanical means and that it is almost entirely by means of infected suckers that new estates become borer infected.

Experiment No. 4.—In connection with this latter result another experiment was carried out. On September 21st twenty-four sturdy suckers, which, however, had not been specially selected for absence of borer, were chosen. Twelve of these were immersed in 1 per cent. solution of formaldehyde for 20 hours. These were then planted out in Plot V adjoining Plots II, III and IV, together with the twelve undipped plants alternating as checks. Of the dipped plants five died completely, whilst in two others the original sucker died, but threw out a bud which grew. When dug up it was found that of the seven survivors five were clean and two had borer. Of the undipped check plants four were clean and eight had borer.

Conclusion.—These experiments have, I think, shown that, although flight does probably take place at times, it is a minor matter in the spread of the pest. They have also shown that the borer is generally sluggish in its habits and is fairly content to stay where it has abundant food. So that if a scheme could be devised to supply growers with clean suckers they would be assured, if they planted on clean or moderately clean land, of a reasonable crop before their estates were seriously affected by the pest.

APPENDIX.

Banana Experimental Plots.

Plot I.—This was the original plot and was laid out with twelve plants. Six of these were in the cylinders and alternated with six check plants in the open. The land had had old banana stumps present before clearing to plant up. Of those plants protected by the cylinder, one was found to have had an insect attack in the original bulb used as a sucker and if borer little doubt was introduced as an egg or minute grub when the plants were put in. In view of others examined later I think, however, this was more likely to be work of some scavenger. All the other plants were healthy and all were beautiful plants. Of the unprotected check plants, one was infected with several borings, whilst a second showed traces in the original bulb similar to the protected one and is, I think, the work of a scavenger. The other four were undoubtedly clean.

Plot II.—This plot consisted of sixteen plants, eight protected by cylinders and eight alternate unprotected checks. As in No. I plot one protected plant had had traces which may have been a single borer in the original bulb or a scavenger, all the rest were clean. Of the eight unprotected checks, three showed traces of borer, one being a heavy infestation, but one of the others was in the original bulb only and like the others seemed more like the work of a scavenger.

Plot III.—In this plot one bulb was removed with borer present on 31st May, 1927, twenty days after planting, and undoubtedly present when put in. When dug out all the plants of this plot in the cylinders proved to be absolutely clean. Of the check plants five were clean, three showed the same insect attack on the original bulb mentioned previously, and three were definitely attacked by borer.

Plot IV.—This plot consisted of eight plants and adjoined two old stumps, one of which was rotten with borer. It was naturally expected that it would prove to be heavily attacked. This, however, proved to be not so.

None of the four protected plants were attacked and only two out of the four check plants were infected (one of these in the original bulb only and more likely the work of a scavenger).

Odd plants.—An old odd plant adjoining plant 3*a* in Plot No. IV was rotten with borer, as were several near Plot I.

A NOTE ON THE AIR SAC MITE DISEASE OF POULTRY IN SUVA.

By Chas. R. Turbet, B.V.Sc., Senior Government Veterinary Officer.

A serious mortality of fowls has recently occurred in Suva. Investigation by the Veterinary Division of the Department of Agriculture resulted in a diagnosis of Air Sac Mite disease being made.

The complete life history of the minute mite, which has the name of *Cytodites nudus* and causes this disease, is not known. The mite, however, gains entrance to the body of the fowl by way of the air passages and lives in the large air spaces in the body of the fowl wandering freely on the membranes. It produces disease by irritating, carrying of disease germs and possibly by the production of a poison in their own bodies which acts on their host. When it exists in large numbers between the lung and the chest wall and in the lung tissue it produces pleurisy or pneumonia or pleuro-pneumonia and causes the death of its host.

The mites cannot occur spontaneously in a fowl run but must be brought there by the introduction of infected birds into the flock.

Control measures.—In introducing new birds into the fowl-run care should be taken that they come from a flock which is above suspicion. New birds should also be isolated as a precautionary measure. The fowl run should not be overcrowded as the chance of spreading infection is greatly increased thereby. When a flock is already infected it is debatable whether it is more econmical to kill off all the fowls, leave the run unoccupied for a time, and then start with new birds, or to kill off obviously infected ones only and treat the flock. If the first method, which is certainly disheartening, is adopted one will be tolerably sure of clearing the disease from the run. If the second method is adopted one might expect periodical outbreaks in the flock with a limited mortality after the first serious outbreak has subsided. When the second method is adopted, treatment might consist of general improvement in the sanitary condition of the fowl-run such as whitewashing with whitewash containing 5 per cent. carbolic acid, liming the soil with fresh lime or chloride of lime, cleaning up rubbish, provision of good water supply and provision of fresh grit. A desert spoonful of sulphur mixed in the mash food for a dozen birds is the best known medicinal treatment for the Air Sac Mite disease of fowls.

A FIBROMA ON EQUINES IN FIJI.

By W. G. Bennett, B.V.Sc., Government Veterinary Officer.

The condition, known locally as Fiji Sore, is quite common among horses in this group, and also in Rotuma. Fairly close study has failed so far to reveal the etiology of the disease, but the history in nearly every case seen suggests that it is caused by an eroded or cut integument that is permitted to remain unhealed, and that is subsequently worried by flies.

In Fiji it is usually seen where horses are kept or worked in muddy or swampy land, but in Rotuma, which has little or no mud, the majority of cases occur on the leeward side of the island. Here the flies are particularly bad, and are suspected of being either casual agents or carriers.

No bacteria have been found in smears made with liquid from a cut surface, but sections demonstrate the presence of a large mass of fibrous connective tissue without blood or other vessels present but with a large number of giant-cells present. This is suggestive of fungus infection by a species of *Sporotrichum*, but no mycelia or fungal threads have so far been discovered. On the other hand it is also typical of a simple fibrous tumour due to severe irritation following upon a failure to dress wounds. In the examinations made no signs of any nematode worms were noted.

Although the cause of this disease has not been definitely ascertained it is clear that strict attention to cleanliness and dressing of wounds on horses are indicated. The application of copper sulphate (Blue-stone) to any tumours which develop can be safely recommended, but the application must be made in the early stages of the tumour, and when made any scabs that may have formed should be removed. Surgical interference has been found unreliable and to give varied results.

SULPHURING OF COPRA.

By Colin L. Southall, B.Sc., A.I.C., Government Chemist.

Some ten years ago extensive experiments were carried out by the Philippine Bureau of Science in regard to the effect of sulphuring copra prior to drying with sulphur dioxide gas. The results published by them were encouraging and it was decided to make experiments in Fiji in the hope that the method would be of use in improving the quality of copra produced.

Accordingly a small gas-tight chamber fitted with sliding trays was erected on Mr. de Mouncey's estate, Wakaya. Freshly cut copra was placed on the trays and sulphur equivalent to 9 lb per 1,000 cubic feet air space burnt in a shallow tray on the floor of the chamber, the door being closed for four hours. Various experiments were made, the most severe being the following:—

A tray of sulphured and a tray of unsulphured copra were placed in a damp concrete shed. Corrugated iron was laid over the trays to prevent rapid drying. Each night the iron was removed and the copra sprinkled with rain water. After eight days of this treatment the sulphured copra was white and free from moulds while the unsulphured copra was a slimy green mass. Both samples were placed on open vatas and sun-dried for three days. The analysis of the two samples was:—

	Sulphured.	*Unsulphured.*
Moisture	5·9 per cent.	5·1 per cent.
Free acid (as Oleic) ..	0·34 per cent.	9·6 per cent.
Colour of oil	White	Light brown.
Appearance of copra ..	White	Very mouldy and brown.

A sack of the sulphured copra was shipped to San Francisco for valuation. The Pacific Oil and Lead Works reported:—" This is about the finest grade of copra we have ever seen and if this quality could be maintained on regular shipment it would bring a premium of at least one-eight cent. per lb over

good grades of sun-dried copra now arriving in this market." The premium quoted is equivalent to 11s. 6d. per ton of 2,240 lb which is disappointing.

Partly in consequence of the above satisfactory experiments Mr. James Harper of Taveuni made a large scale experiment on his plantation. He built a chamber with a capacity of 4,000 lb wet copra. For a number of reasons the sulphuring was not as efficient as in the smaller box. The conclusions arrived at as a result of these and the previous experiments were:—

1. Sulphuring of copra enables a first-grade copra to be made on open or running vatas even when heavy rain falls on the copra.

2. Sulphuring of semi-dry copra that is rapidly deteriorating prevents any further loss by mould action.

3. Sulphured copra will not dry out into first-grade copra when kept under cover in a poorly ventilated shed. (This does not agree with the results reported in the Philippines).

4. Sulphuring of copra entirely prevents the "burning" of copra on open vatas in hot weather.

6. The actual cost of the process is not heavy. The small premium of 11s. 6d. a ton quoted would probably be absorbed by labour and interest on the chamber, but it should be taken into account that careful experiments have shown that there is a loss in weight of 12½ per cent. when copra is prepared by the ordinary open vata method, a considerable proportion of which would be saved by sulphuring. Furthermore, there is a danger of further price discrimination against bad grades of copra.

7. Sulphuring may, therefore, be said to be of considerable advantage to small producers, particularly those situated in wet districts who are not in a position to install mechanical driers. No details in regard to the actual type of chamber, &c., are given here because a further test is being made shortly with what is hoped will prove an efficient yet cheaply erected chamber.

DETERIORATION OF COPRA ON STORAGE.

By Colin L. Southall, B.Sc., A.I.C., Government Chemist.

Experiments carried out during the winter of 1927 to determine the loss caused to copra by drying on open vatas pointed to the fact that further loss occurred after the copra was removed from the vata to storage. To determine if possible the condition resulting in loss and the amount of loss the following experiments were made:—

(*a*) Change in acidity of three commercially prepared samples of copra;

(*b*) slow drying of copra on open vata for 14 days followed by three months' storage;

(*c*) storage of commercially prepared copra for three months and estimation of loss at intervals;

(*d*) rapid drying of copra on open vatas and removal to storage for three months.

(*a*) *Change in acidity on storage.*—The loss of copra was unfortunately not determined, but nevertheless the results are of interest:—

Copra.	23–10–27.		10–12–27.		7–1–28.	
	Water.	f.f.a.	Water.	f.f.a.	Water.	f.f.a.
1	9·1	4·6	4·9	12·2	4·7	11·8
2	7·1	2·9	4·8	4·2	4·7	4·4
3	7·4	2·1	4·8	4·9	4·6	4·9

The copra arrived in Suva on 22nd October, 1927, for shipment to Europe. Sacks of each brand were held back and stored with other copra in a bulk store, being examined at intervals.

(*b*) *Changes during slow drying on open vatas for* 14 *days followed by storage for three months.*—On the 14th day the copra was bagged and stored with other copra:—

	Slow drying on open vatas.		Storage in presence of other copra.	
	1st day.	14th day.	55th day.	99th day.
Moisture	45·6	8·0	4·8	4·6
Oil content of anhydrous copra ..	68·4	69·9	70·6	70·4
Acid in oil (as oleic)	0·2	6·5	9·9	9·8
Loss anhydrous copra	..	10·9	14·6	15·0

(*c*) *Storage of commercially prepared copra for three months and estimation of loss at intervals.*—The copra was taken at random and stored with other copra. Only moisture and loss of copra were determined:—

Copra.	Originally.	Two months.		Three months.	
	Moisture.	Moisture.	Loss of copra anhydrous	Moisture.	Loss of copra
1	7·4	4·9	5·1	4·6	5·4
2	6·8	5·1	4·0	4·8	3·9
3	9·3	4·8	8·3	4·6	8·7

(*d*) *Rapid drying of copra on open vatas and removal to storage for three months.*—This experiment was designed to follow as nearly as possible normal working methods in Fiji. Two sacks of copra were dried as rapidly as weather conditions permitted on an open vata and bagged after four days. They were then stored with other copra for three months, being tested once during the interval. The first sample was dried during fair weather and the second sample during bad weather, being rained on on each of the four days:—

COPRA No. 1.

	Drying.		Storage.	
	1st day.	4th day.	47th day.	89th day.
Moisture	45·9	8·8	4·9	4·6
Oil in anhydrous copra	68·7	68·6	69·4	69·3
Free acid in oil (as oleic)	0·2	2·0	6·8	6·4
Loss anhydrous copra	..	1·1	8·9	9·3
COPRA No. 2.				
Moisture	45·7	15·2	5·0	4·8
Oil in anhydrous copra	68·4	68·6	73·0	72·6
Free acid in oil (as oleic)	0·2	3·2	16·4	16·0
Loss anhydrous copra	..	2·1	20·1	20·8

In all the above experiments allowance must be made for errors. Satisfactory sampling of copra is not easy and no conclusions should be drawn from small discrepancies between the above figures.

Conclusions.—Assuming the tests made to be typical I think the following conclusions may be drawn:—

(1) Copra containing less than 6·0 per cent. moisture does not deteriorate to any great extent when stored in sacks in bulk.

(2) Copra containing over 6·0 per cent. moisture when stored under conditions where it only loses moisture slowly (i.e., in a heap of sacks) deteriorates very considerably. A loss up to 20 per cent. anhydrous copra may occur.

(3) There does not appear to be a simple mathematical relationship between increase in f.f.a. content and loss of copra, although I am of the opinion that the loss of copra is at least equal to the acidity of the oil. In normal experiments the proportion of loss of copra to free fatty acid was as 10 in 7·5.

NOTES ON THE PRICKLY SOLANUM.

By J. D. TOTHILL, D.Sc., Superintendent of Agriculture.

SINCE July, 1928, a considerable correspondence has taken place between the Government as represented by the Department of Agriculture and officials in various countries with a view to ascertaining whether there is any prospect of bringing about by biological means a control or partial control of the prickly bush known botanically as *Solanum torvum* Schwartz. The mere fact that the plant belongs to the potato family which includes many plants of economic importance (c.f. short list at end of this article) in the tropics renders it unlikely that there is in any part of the world an agent destroying this plant to such an extent as to be useful that does not also feed upon at least one plant of economic importance. However, the subject of biological control is one in which the unexpected sometimes happens and consequently it has seemed advisable to proceed at least so far as to explore the possibilities.

The first point to settle was the name of the bush which for many years was known in Fiji as *Solanum tetrandum*. When, however, in 1926 the Ordinance dealing with weeds, known as the Noogoora Burr Ordinance, was extended to include this plant the writer attempted to verify the name but in so doing came to the conclusion that the plant was not *S. tetrandum* at all but a different species *S. torvum* Swartz, and it was therefore gazetted under this name which has since been verified by the Director of Kew Gardens, to whom specimens were sent. This matter of accurate determination is important because insects sometimes exercise a food preference for one only of two or more closely related plants.

With the name settled the next step was to ascertain the distribution of the plant so as to know where to look for insects that might feed upon it. In reply to a letter on this point Dr. Arthur Hill, the Director of the Royal Botanic Gardens, Kew, says:—

The specimen forwarded is a typical example of *Solanum torvum* Schwartz. This species is a common weed in cultivated ground and forest clearings in Tropical Asia, Malaya, Philippines, West Africa, Mexico, West Indies and Tropical South America, but it is difficult and at the present time perhaps impossible to state in which countries it is truly wild.

Solanum torvum is not usually regarded as a noxious weed in these countries, but a form of the species, not identical with the one you send from Fiji, is regarded as noxious in certain parts of Queensland; but there are many varieties of *S. torvum* and some of these should perhaps be considered as distinct species.

Your specimen exactly matches material we have from India and the West Indies, but this does not necessarily imply that India is its native country, though I think it would be well worth while to apply to the Agricultural Research Institute, Department of Agriculture, Pusa, Bihar, India, with regard to insects which feed upon it.

The Keeper of the Arnold Arboretum, Mr. E. H. Wilson, kindly sent the following information in a letter dated 5th August, 1928:—

Swartz in his original description, published in his "Nova Genera & Species Plantarum Seu Prodromus," p. 47, 1783-87, gives the West Indies as the original habitant of this plant. The "Index Kewensis" says that is is cosmopolitan within the tropics. To our knowledge it is found almost everywhere in the tropics of both hemispheres, and it is impossible to say which was its original home. However, in all probability it is a New World species. In this Herbarium we have material collected in—

Am.	*Geront.*	
Cuba	India	Assam
Mexico	China	Java
Jamaica	Burma	
Porto Rico	North Borneo	
Grenada	Luzon	

In addition I know the plant in Western China, Australia and in tropical Africa.

On July 5th the following letter was sent to Dr. G. A. K. Marshall, C.M.G., the Director of the Imperial Bureau of Entomology, setting out the proposal generally and asking for suggestions:—

This is to advise that the Government has undertaken to make preliminary inquiries as to the possibility of a biological control for the plant *Solanum torvum* Swartz which, presumably was introduced here from India and which now ranks as one of the principal weeds in the Colony. Graziers particularly are disturbed at its rapid progress as, on account of the prickles, the bush is difficult to deal with manually and it is now blocking up some of the best grazing lands in the Colony.

2. The Government is not so far committed to any course of action and replied in the following terms to a question asked in Legislative Council. These terms indicate the official position:—

1. In view of the fact that *Solanum torvum* is closely related to many plants of economic importance it is unlikely but not impossible that insects can be found to feed upon it that would not become injurious to economic plants.

2. Government is aware, however, that the plant in question is a pest of considerable importance and will undertake to make inquiries by correspondence with entomologists in India with a view to obtaining further information.

3. The Superintendent of Agriculture expects to pass through India on leave in about eighteen months' time, and if the results of inquiries are sufficiently encouraging would be prepared to look into the matter and submit recommendations to the Government.

3. I have no set formula but as an initial step have written to Kew for an official determination of the plant which I have provisionally called *Solanum torvum* Swartz.

4. I propose writing to various entomologists in India, Burma and the Federated Malay States asking if they can give me any information on insects that may feed upon the fruit, leaves, stems or roots of this plant and that are not known to attack any plant of economic importance, I am not very hopeful that these inquiries will lead very far for two reasons, one being that there are so many economic plants in, or close to, the genus *Solanum*, and, secondly, because it is doubtful if very much is known anywhere about the insects that attack this plant on account of the fact that in most places it is not of economic importance. I shall greatly appreciate any suggestions you can make in regard to this subject.

Dr. Marshall's reply is here quoted and it will be noted that he assumes, as I had feared, that the problem may be beset with rather more than the usual number of difficulties:—

I must confess that I am in close agreement with the official view which you quote. I certainly think that it would be very risky to attempt the introduction of any insect that attacks *Solanum*, even if in India it is not known to attack anything but a wild plant. The controlling factors in a country like India would probably be non-existant in Fiji, and an introduced species would be likely to behave in a different manner. The probability is that it would become much more abundant, and this would increase the chance of its attacking cultivated *Solanaceae*. It seems to me that the steps you are proposing to take are the best that can be done in the matter, and I cannot think of any further suggestions that are likely to be of use to you.

Letters were then sent to various officials in Ceylon, India, Burma and the Federated Malay States asking for information regarding insects known to feed upon this plant. Replies have now come to hand and for the most part are not encouraging as there seem to be no insects of outstanding importance feeding upon the plant in those countries. This rather suggests that Asia may not have been the original abode of this plant and that it was introduced to Asia from Tropical America.

A few excerpts from this correspondence may be of interest. In Bombay Presidency the Economic Botanist to the Government, Mr. W. Burns, says that the plant is not found wild but that it occurs as a cultivated plant in gardens (letter 9th October, 1928).

Mr. R. C. Broadfoot, Cotton Specialist in the Agricultural Department, writes under date of 29th September that the plant is a common shrub in South India on road-sides and waste places and that it does particularly well where rainfall and humidity are high; the common insects on it are *Epilachna*, a fruit fly, and a fruit borer, all three of which occur on Bringal (*S. Melongena*). The Imperial Entomologist at Pusa, Mr. Bainbrigge Fletcher, says that the plant "is a common wild plant in most parts of India," and suggests "that it would be hazardous to introduce any insects from India into Fiji as they would be likely to attack *Solanum Melongena* (Bringal). The Entomologist for Burma, Mr. C. C. Ghosh, writes that *S. torvum* is a common weed in many places in Burma and says "the only insect I have observed on it, only occasionally, is *Pachyzancla bipunctalis*, the larvae of which web up and feed on the leaves." The Director of Agriculture for Ceylon, Mr. F. A. Stockdale, writes (Sept. 11th) that *S. torvum* "is a common weed in waste places around Kandy, but at the time of special examination by the Entomologist toward the end of August of this year it was not found to be affected with insect pests," and says further, "I am not aware of any insect in this country which could be expected to be of use for the biological control of this plant in Fiji." In a list of insects attacking plants in the potato family in Ceylon drawn up by the Entomologist, Mr. J. C. Hutson, and attached to the above letter the

only ones recorded for *S. torvum* are *Epilachna* sp., which is a leaf-feeding beetle and two plant bugs, *Diphinctus humeralis* and *Aphis gossypii*, the latter of which is an important cotton pest.

The only insect of possible value mentioned in this correspondence occurs in the Federated Malay States. The Entomologist, Mr. G. H. Corbett, says under date of September 28th, "I have caused collections of insects on the plant to be made and have found a promising enemy of the fruit. Specimens of this Microlepidopteron . . . were sent to Dr. G. A. K. Marshall for identification yesterday. I also asked him to supply any further information concerning this insect . . . I feel that the possible reason why this plant is not considered by the Agriculturist to be troublesome is on account of the large percentage of fruits damaged by this moth."

This completes the information obtained so far. As the plant occurs in Tropical America and also in West Africa letters have recently been sent to appropriate officials in various countries situated in those continental areas asking for further information. Replies cannot be anticipated for several months, but when they become available I hope to be in a position to make a further report.

It may be of interest to mention some of the commonly grown plants of economic importance coming in the potato family or *Solanaceae*:—

Chillies—Capsicum species (a number of kinds).
Tobacco—*Nicotiana, Tabaccum* and *rustica.*
Tomato—*Lycopersicum esculentum.*
Bringal or egg-plant—*Solanum Melongena.*
Cape Gooseberry—*Physalis peruviana.*
Tree tomato—*Cyphomandra betacea.*
Potato—*Solanum tuberosum.*

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